Transportation Synthesis Report

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Snowdrift Control

Prepared for
Bureau of Highway Operations
Division of Transportation Infrastructure Development

Prepared by
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WisDOT RD&T Program
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Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WisDOT technical staff in highway development, construction and operations. Online and print sources include NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs, and related academic and industry research.

REQUEST FOR REPORT

Sparkling snow, shimmering ice—winter coats the lands and waters along highways in the snow belt states with dazzling beauty for travelers. In some spots, though, crisp winter winds blow large amounts of snow toward the roadway, and several inches or more can quickly accumulate on the pavement.

These "snowdrifts" can be serious safety hazards.[1] They can cause loss of vehicle control, reduce sight distance on curves and at intersections, obscure signs, promote ice and slush formation, reduce effective road width and render safety barriers ineffective. Snowdrifts are costly in other ways, too:

- In exposed, windy locations, the amount of snow that blows onto a road can be hundreds of times greater than snow that falls directly on the road, with the result that most plowing time is spent removing wind-deposited snow. Typically, mechanical snow removal costs about $3 per metric ton.
- By promoting the infiltration of water under pavement, snowdrifts can contribute directly to pavement damage. In addition to serving as a water source, drifts can adversely affect drainage by blocking ditches, drains and culverts. Snow removal equipment can also damage road surfaces.
  ([1]*Design Guidelines for the Control of Blowing and Drifting Snow*, Ch. 2.2: The Importance of Drift Control, SHRP-H-381, Ronald Tabler, http://gulliver.trb.org/publications/shrp/SHRP-H-381.pdf)

Highway snowdrift control is a top priority for WisDOT. Roadway Maintenance Engineer Tom Martinelli says that drifting snow contributes to accidents on Wisconsin highways. (Because the state's police accident reports do not include a check-off box for "snowdrift-related," no hard data or statistics are available for now.) Snowdrift control also reduces the amount of snow that has to be plowed, the amount of deicing materials that have to be applied, and the amount of time that plow drivers have to spend on cleanup after a snowstorm.

As part of the effort to control drifting, the RD&T Program was asked to research several key topics:

- Living snow fences. How are other states designing and planting them? This information would be used to benefit Wisconsin's living snow fence program.
- Guardrail weeds. Weeds left uncut along guardrails encourage snow to drift over guardrails and onto roadways. Do other states have policies about weed cutting at guardrails?
- Causeways. Wisconsin and other states have causeway structures where blowing snow creates safety and maintenance problems. Have other states found effective solutions?
- Highway planning. Are other states designing roads to discourage snowdrift cover?

SUMMARY

We located a number of states other than Wisconsin with living snow fence programs, and summarize below the design and planting guidelines used by six of the programs. Minnesota DOT's living snow fence program is an especially interesting model that factors in careful planting and maintenance, climatology and case studies. (See **Living Snow Fences**, pp. 2-5 below.)

Indeed, uncut weeds beneath a guardrail will exacerbate a snow drifting problem there, according to Dr. Ron Tabler, Principal of Colorado's Tabler and Associates, consultants in snow and wind engineering. "Here in the West we do roadside mowing diligently in the fall," Ron says. "Weed cutting should be scheduled before the first storm in the fall. Around guardrails and delineator posts, we use Roundup, or maybe go out with a weed cutter. Some years, these efforts make an especially big difference in snowdrift mitigation. Over time, the practice pays for itself through a reduction in driver accidents." Maintenance and landscape staff from several state DOTs share their insight in **Guardrails**, pp. 5-6 below.

Regarding causeways, Ron shares some thoughts about how WisDOT could confront its causeway-drifting problem. The Vermont and North Dakota DOTs have found some solutions that work. Minnesota DOT is looking at two features to minimize snow drifting on Minnesota's 1,800-foot-long Pokegama Lake Causeway. (See **Causeways**, pp. 6-8 below.)

Concerning highway design, New York State DOT tells us that highway planners there will soon test a CADD-based expert system called SNOWMAN for blowing snow control. When designing roadways, Wyoming DOT evaluates snowdrift profiles and North Dakota DOT considers snow drifting and collection. The Iowa State University Center for Transportation Research and Education suggests that the best way to control drifting snow may be to shape the roadside landscape appropriately, ideally when the roadway is designed. However, the topography of existing roadways can sometimes be reshaped or improved in ways to control drifting snow. There are a number of practical publications at TRIS Online and other sites concerning road planning for snow control. (See **Highway Planning**, pp. 9-11 below.)

Meantime, efforts to improve snow and ice control on European roads and bridges is getting collective attention through an exchange platform involving 19 countries. (See **In Europe**, p. 11 below.)

LIVING SNOW FENCES

WisDOT living snow fences

Contact: Richard Stark, Landscape Architect, at Richard.Stark@dot.state.wi.us

WisDOT primarily uses evergreen trees, especially in the northern part of the state where evergreens are indigenous, or shrubs. "We encourage the use of shrubs for several reasons," Dick says. "Shrubs are more effective for a longer period of time. Evergreen trees are conical in shape and are not too effective until they grow large enough so that they have grown together. Then they are effective for a few years until they get bigger and start losing their lower branches, which results in reduced effectiveness again. Shrubs are indigenous statewide while evergreens are more of a 'northern' plant. Lower growing shrubs don't block the view of the surrounding countryside for travelers."

(Dick notes that WisDOT also utilizes artificial snow fencing, made up of the standard wood-slat snow fence that has been around for years, as well as the more recent plastic mesh fencing. The latter may be hung on existing security fences if available or on steel fence posts driven in for the express purpose of the snow fence.)

Climatological Characterization of Snowfall and Snow Drift in Minnesota (for the Design of Living Snow Fences)

Mn/DOT

http://climate.umn.edu/snow_fence/intro.html

Before a blowing snow problem can be solved, several climatological factors in the area of interest must be investigated. For this study, climatological records of snowfall, precipitation and temperature were compiled and archived in digital format for all observing stations in Minnesota. With these data in hand, the climatological parameters needed to design a living snow fence were computed, and several features of the impacts of living snow fences were investigated. Among the key findings: the three living snow fence designs performed exceptionally well for the near record-setting winter of 2000-01, storing 50 percent of their theoretical capacity and protecting their respective roadways from drifted snow. A user is now able to view previously unavailable snowfall and wind

climatological products (Analysis of Snow Climatology, http://climate.umn.edu/snow_fence/) and utilize these products to follow the guidelines to design a living snow fence in an interactive, Web-based environment (case studies, http://climate.umn.edu/snow_fence/Components/casestudyhome.htm).

Designing living snow fences
University of Minnesota Design Module
http://climate.umn.edu/snow_fence/Components/Design/introduction.htm
Online tool for using road design and snow fences to control snow on roadways. Guides participants through the process of designing a living snow fence.

Dan Gullickson, Living Snow Fence Coordinator for Mn/DOT, says that the typical living snow fence design for Minnesota is a high-density, twin shrub row that reaches a 10-foot height and is set back 150 to 300 feet from the highway right of way line. Fence setback is determined by the snow transport, Dan says. "In western Minnesota, the snow relocation coefficient is almost 69 percent, compared to eastern Minnesota, where the snow relocation coefficient can drop to 10 to 20 percent. This means that the fences need to be set back further in the western part of the state." The plant material typically used in Minnesota is red-twigged dogwood, gray dogwood, American Cranberry Viburnum, Arrowwood Viburnum, Nannyberry Viburnum, American Plum, Common Ninebark, Lilac and Honeysuckle. "Other states place an emphasis on using spruce, pine or cedar," Dan says. "In Minnesota, we have observed that we get a more uniform snow drift with shrubs due to their uniform density. With evergreens we tend to see finger drifts protrude in the gaps between the trees. If evergreens are used we recommend placing a shrub row downwind of the evergreens to close the gaps." Dan can be reached at 651-284-3763 or daniel.gullickson@dot.state.mn.us for more information.

Maintaining Living Snow Fences
Mn/DOT Office of Environmental Services
http://www.livingsnowfence.dot.state.mn.us/snowfence_growandmaint.pdf
Contact: Dan Gullickson at 651-284-3763 or daniel.gullickson@dot.state.mn.us

- Mowing. For the first two growing seasons, mow two times per year between July and Sept. 15. Mow the turf to a height of six to 10 inches; a cornstalk chopper works well. Mowing also maintains firebreaks and keeps brush from spreading into the grassland buffer strip. Mowing helps establish native grasses by permitting sunlight to reach the sprouting seeds.
- Re-anchoring landscape fabric. Make sure the staples secure the fabric tightly to the ground. This prevents the wind from picking up the fabric and blowing it away. Landscape fabric serves as a weed barrier, moderates soil temperatures and conserves moisture to create favorable living snow fence root development.
- Controlling weeds (April to November). Control all noxious weeds as identified by state and local laws, and weeds that interfere with the establishment of the living snow fence. Use non-chemical methods first (e.g., hand pulling weeds that come up through the fabric slits near the plant). If a chemical method is the only practical alternative, call the natural resource specialist for advice on the selection and application of herbicides. Always read and follow the herbicide label directions. The weed control method chosen must not injure or damage the plants in the snow fence.

Living snow fence case studies with photos
Gaylord, Lamberton and Mountain Lake, Minnesota
http://climate.umn.edu/snow_fence/Components/casestudyhome.htm

From: Iowa DOT's booklet *Iowa's Cooperative Snow Fence Program*
http://www.dot.state.ia.us/maintenance/snowfence/snow_fence_booklet.pdf
Living snow fences need to be placed back from the roadway a distance of 15 times the mature height of the plant. Species are selected and placed to create the space needed for a snow fence when the plants reach maturity. The goal is to establish a living fence that not only survives and grows fast, but also remains effective over a long period. Windbreaks made of deciduous trees and shrubs have been used for years. Trees and shrubs should be planted in rows running parallel to the roadway. Two rows or more provide the most effective wind protection. Species selection is determined by the soil type and fertility, as well as the surrounding vegetation. Because soil types vary around the state, each living snow fence may be custom designed to suit that area.

More from: ***Technology News*****,** ***September-November 2001***
Iowa State University Center for Transportation Research and Education
http://www.ctre.iastate.edu/pubs/Tech_News/2001/sepoct/managesnowdrift.pdf
Contact: Dennis Burkheimer, Iowa DOT winter operations administrator, 515-239-1355, dennis.burkheimer@dot.state.ia.us.
The Iowa DOT's general living snow fence design consists of two rows (five feet apart) of trees and shrubs, with plants spaced three feet apart within each row.

South Dakota Dept. of Agriculture Living Snow Fence Program
Design and Location of Living Snow Fences
http://www.state.sd.us/doa/forestry/snow_fence_design.htm
The windward row should be located no closer than 200 feet from the centerline of the road. This will allow adequate room for snow storage during severe blizzards. The planting needs to be extended 100 feet beyond the area protected to prevent snow from sweeping around the ends of the planting. At least two rows of conifers (junipers) and a shrub row are needed to provide a dense and effective barrier. One of South Dakota's most effective living snow fences, located along Interstate 90 just east of Rapid City, is composed of five rows: Rocky Mountain. juniper, Russian-olive, green ash, Russian-olive and Rocky Mountain juniper. It is doing a remarkable job of controlling snow.

Montana: Fallon County, Little Beaver Conservation District
http://mt.nacdnet.org/LBCD/page2.html
Recommended site preparation is fallowing for two years on grazing lands and one year on agricultural lands to store moisture and control weeds. A minimum of three rows in the snow fence is recommended for wind control and added snow storage. Fencing on grazing lands is needed to protect the planting from grazing and trampling.

Living Snow Fences in Kansas
Kansas Forest Service, Kansas State University
http://www.oznet.ksu.edu/library/FORST2/L744.PDF
Living snow fences usually are planted on the north side of east-west roads, or on the west side of north-south roads. The distance from the planting to the road depends on the type of ground cover and the terrain on the windward side. In flat open terrain, the windward row should be 150 to 250 feet from the center of the road. Do not create a "blind corner" by planting living snow fences too close to an intersection. Living snow fences should contain at least two rows of dense evergreen trees. Eastern red cedar or Rocky Mountain juniper are especially well suited. An additional row or two of shrubs will improve the snow-trapping ability while greatly enhancing wildlife habitat. Spacing within the row should be six to eight feet between trees and three to four feet between shrubs. Between-row spacing ranges from eight to 20 feet. Both ends of the planting should extend at least 100 feet beyond the area prone to drifting. This eliminates snow sweeping around the ends of the planting and accumulating in the protected area.

Living Snow Fence Program
Wyoming: Laramie County Conservation District
http://www.lccdnet.org/living_snow_fence.html#Installing
Initial site preparation is completed in the fall. Sites subject to grazing are fenced to protect the seedlings. To accomplish this, the district staff and seasonal employees utilize the district's tractor and posthole auger. Temporary snow fence is installed to aid in soil moisture storage for seedlings. Seedling trees and shrubs are planted from April to early June. Fabric mulch is placed over each tree row following planting to reduce moisture-competing weeds and grasses. Fabric mulch also holds moisture in the soil, thereby reducing the need for supplemental watering. A three-year maintenance program has been established for each site. During this period, conservation district personnel provide regular inspection and control for insect, disease and rodent problems, and replant trees that do not survive. Anti-transpirant materials are applied to sites for three years to aid in winter stress on newly planted trees. (The district completed a comprehensive list of its 176 living snow fence sites by year including the site number, year established, landowner, legal description, and if signage has been installed. This information is now located on the district's GIS database. Also on GIS is a maintenance record keeping system of each site to document every maintenance function performed.)

North Dakota DOT
Contact: Ed Ryen, Assistant Maintenance Engineer
eryen@state.nd.us
NDDOT has a living snow fence program in cooperation with the Federal Emergency Management Agency (FEMA), the ND Forest Service and landowners. Living snow fences are being planted in the most problematic areas.

Design Guidelines for the Control of Blowing and Drifting Snow
SHRP-H-381, Ronald Tabler
http://gulliver.trb.org/publications/shrp/SHRP-H-381.pdf
Click on bookmark for Section 6: Living Snow Fences
This book provides all of the information needed to design effective and economical measures for controlling snowdrifts and reducing the concentration of snow in the air. Section 6 presents engineering guidelines for vegetative barriers based on the same principles and quantitative relationships used for structural snow fences.

GUARDRAILS
North Dakota DOT
Contact: Ed Ryen, Assistant Maintenance Engineer
eryen@state.nd.us
"The weeds and guardrails both cause snow drifting," Ed says. "Not only is the drifting a problem, but the snow removal is a problem, just because the guardrails themselves get in the way of the snow removal process. NDDOT does have a policy to remove or mow all weeds around guardrails. Some of our districts use sterilants to kill the weeds, but we also use asphalt pavement around the guardrail to prevent weed growth. All of our R/W is mowed late in the fall to reduce snow collection in the ditches and around guardrails."

Wyoming DOT
Contact: Ken Shultz, State Maintenance Engineer
kshult@dot.state.wy.us
"Wyoming doesn't have a written policy on such, but our observations are similar," Ken says. "We use many different techniques to reduce this problem: trimming under and around the rail, herbicides that retard or prevent this growth close to the guardrail, etc. Control of this growth is a standard course of action, because we can't afford the consequences of not taking action."

Vermont Agency of Transportation
Contact: Craig Dusablon, Landscape Coordinator
Craig.Dusablon@state.vt.us
"We spray herbicide beneath our guardrails to regulate plant growth," Craig says. "We are restricted from spraying herbicides within 15 feet of all state waters and 30 feet before the approach to bridges. We have a couple of causeways in our Lake Champlain Region. Only when water levels are down from the 15-foot buffer are we allowed to spray."

Minnesota DOT
Contact: Dan Gullickson, Living Snow Fence Coordinator
Daniel.Gullickson@dot.state.mn.us
"Our maintenance crews use chemical and mechanical means of controlling vegetation along guardrails."

From: ***Technology News, September-November 2001***
Iowa State University Center for Transportation Research and Education
http://www.ctre.iastate.edu/pubs/Tech_News/2001/sepoct/managesnowdrift.pdf
Minimize the use of roadside guardrail. Roadside guardrail can trap snow on the roadway. For example, building gentler slopes on embankments and ditches and extending culverts can reduce the need for guardrail. However, when guardrail is necessary, choose designs that interfere as little as possible with snow removal activities. Of the four common designs—box-beam, cable, concrete and W-beam—box-beam and cable may be preferable because they allow better airflow and interfere less with snow removal activities. Blowing snow can move more freely

through box-beam guardrail but tends to collect in drifts near W-beam rail. Modify existing guardrail so it doesn't collect drifting snow by anchoring the ends in the back slope or flaring ends away from the roadway. (For more information regarding the snow drift implications of guardrail, contact Safety Circuit Rider Tom McDonald, 515-294-6384, tmcdonal@iastate.edu.)

Four-cable guardrail on US 85 at Windy Point
Project manager: Skip Outcalt, 303-757-9984, skip.outcalt@dot.state.co.us
In areas with a drifting snow problem, guardrails can act like a snow fence and cause snow to drift across the highway. The Brifen system, a four-cable guardrail system that greatly reduces the drifting problem, has been used extensively in Scandinavia with considerable success. The Brifen design, which recently received NCHRP 350 approval, could be very useful in Colorado. Deflection, when the guardrail is struck by a vehicle, is substantially less than with other designs, and maintenance is simple, fast and inexpensive. This study will monitor the performance of two sections of Brifen guardrail that were installed in September 2002 on US 285 at MP 141. Data from the site will help determine the usefulness of the Brifen guardrail for applications in other areas.

North Dakota DOT
Contact: Ed Ryen, Assistant Maintenance Engineer
eryen@state.nd.us
"One change we are making is the removal of cable guardrail at structure underpasses, and placing crash barrels at the piers. This eliminates snow storage problems when plowing snow around these structures and therefore eliminates snow drifting."

CAUSEWAYS
The problem location is in Winnebago County, northeastern Wisconsin. A section of US 41 crosses Lake Buttes des Mortes as a series of bridges and fill over the lake. The average traffic volume is 63,000 vehicles per day. During winter the lake freezes almost entirely and snow blows across the ice on the lake up on to US 41. The blowing and drifting snow on the highway become a maintenance problem, very serious at times. Several conventional snow attenuation devices have been tried at the site, but no effective solution had been found as of March 2003. WisDOT has proposed a research project that would provide information on type, location, effectiveness and cost of different types of snow fence applications. Existing snowdrift theory has formulas that provide the correct height, offset and type of snow fence that should be effective in this situation. The research project would test the formulas. The study is of an urgent nature since the safety of traveling vehicles is at stake. Also, a multimillion dollar project is being planned to reconstruct the bridge and causeway within the next few years, and the research could be incorporated into the design.

From Ron Tabler, Tabler and Associates, Niwot, CO
Contact Ron at tabler@sprynet.com, or 303-652-3921
"Attachment of fences to the causeway is probably not a workable solution," Ron says, "and installing temporary fences in the ice would be too labor intensive and expensive. There are several methods you could look into:

- "An artificial dike: In a situation where you have ice on both sides of the causeway, there's the possibility of building up an artificial dike on either side of the causeway, and putting in structural fencing or a living snow fence.
- "A bubbler system: Most drifting snow travels by 'saltation'—bouncing off of a hard surface. Open water traps saltation. A bubbler system could be designed to keep the water open near the causeway. You would probably want to keep the water open to a distance of at least 20 feet from the upwind side of the causeway.
- "A solid barrier: Snow would blow over the top of a tall, solid barrier built on the upwind side. Some initial testing should be done with a wind tunnel model.
- "A structural snow fence built out in the lake.
- "Keep in mind that highway safety barriers and some types of guardrail exacerbate drifting problems.

"Overall, if a road drifting problem is severe enough, you'll find that the cost to mitigate the problem is paid off in a year or two in the reduction of accidents and fatalities."

Vermont DOT
Contact: Gil Newbury, District 8 Transportation Administrator
Gil.Newbury@state.vt.us
"In my district we have five causeways," Gil says. "As a former resident of Peshtigo, WI, I can say that the snow belt in Northern Vermont coming off Lake Champlain is pretty similar to the snow belt in northern Wisconsin. In my opinion, snow is not the real problem on causeways—wind is. The wind drives the snow, causing drifts, more maintenance, etc. etc. We try to use the wind in our favor, rather than fight it. For example, we try to use guardrail on our causeways that has very low wind shielding. That is, lets the wind blow right through it. We have three-cable and box beam. We try to get rid of W-beam rail on causeways where we can. Our theory, and practice, is to let the wind blow the snow across the causeway and don't give it any opportunity to fall out of the wind and onto the road. What does fall on the road, we try to keep the road dry so the snow particles bounce and roll off the causeway, or at least to the edge of the road. We use sand or very light applications of salt to keep the road dry. Many people feel that if they don't use a significant charge of salt that the snow will cake on the road and they will 'lose' the road. Our practice shows that is not the case. I can recall one situation where we did not have the funding to change the guardrail on both sides of the road. So we switched the W-beam rail on the upwind side of the prevailing wind to eliminate wind drifting of snow on the road. We had drifts on the downwind side—but it was off the road for the most part. Not ideal, but better than nothing.

"As you know, the real issue with snow fencing is storage—of snow. Your snow fence is only good until the storage on the downwind side fills up. Then you've lost the entire benefit of the snow fence because the snow blows right past it as it did before. Traveling through the prairie states I have seen snow fencing arrayed in rows or banks. This is one way of increasing storage capacity. The upwind bank fills up first, wind blows snow to the next row which fills up over time, then on to the third… Here in Vermont we seldom have enough right of way to space one row of snow fence at the correct storage distance from the road, let alone multiple banks. And we certainly don't have much space on our causeways!

"In the western states I have seen another theory in practice where they erect very tall, permanent snow fences. This allows them a large volume of storage in one row of snow fencing. Again, here in Vermont we don't have the right of way for the long downwind storage 'shadow' that these structures cast. Also, not practical on a causeway.

"I agree about uncut vegetation under guardrails causing snow to drift on the road. The three-cable and box beam rail mentioned before help keep that at bay, but we pay extra attention to weed control on our causeways for that very reason. Many of my causeways are built on large rock bases and side slopes and are a bit narrow, so there isn't a lot of soil to promote weed growth. If we can't stay ahead of it in the summer we make sure we hit it in the fall."

Minnesota DOT
Contact: Brian Larson, Minnesota DOT Project Manager
218-723-4960 ext. 3322 or Brian.Larson@dot.state.mn.us
"We're looking at two features to minimize snow drifting on the 1,800-foot-long Highway 169 Pokegama Lake Causeway," Brian says. "The new causeway will have a longer bridge (250 feet) that will let blowing snow pass underneath. We are also using a box beam guardrail that is more open than the existing W-plate beam guardrail. Our experience with the Pokegama Lake Causeway is that when the old, three-cable guardrail was replaced by the plate beam style, snow drifting increased substantially on the highway. We feel the proposed box beam guardrail will decrease the amount of drifting but probably not eliminate the problem. Other options that were discussed included 1) trying to provide areas of continuously open water to catch blowing snow, 2) constructing manmade islands away from the causeway as snow catchment areas and 3) raising the profile/grade of the highway above the elevation snow drifting would occur in a normal winter. These options would be effective but were dismissed as not being practical for the location or environmentally friendly."

North Dakota DOT
Contact: Ed Ryen, Assistant Maintenance Engineer
eryen@state.nd.us
"In ND there are structures that have a particular problem with snow drifting and zero visibility, resulting in the highest winter accident rate in ND," Ed says. "The structures are a pair of bridges on I-29, MP 114, north of Fargo, known as the Buxton Bridge. These structures are on a vertical and horizontal curve, adding to the problem. The snow would drift onto the structures, causing slippery conditions resulting in numerous accidents. To help resolve

the problem, I designed a series of structural snow fences to cut down on the snow drifting and visibility problems. The first winter after installation, the Fargo district and Highway Patrol reported a great improvement in visibility and snow deposition on the structures, therefore reducing accidents. The NDDOT also has a living snow fence program, and the Buxton Bridge now has a living snow fence along with the structural snow fence.

"The snow fences have greatly improved visibility and reduced snow deposits, but as you may know, bridge decks can still get slippery because of the exposure of the deck to weather elements. We also installed a deck sprayer system (in fall 2002), and with the snow fences and the spray system, we have had NO accidents the following winter. This is a first since the structures were built in the 1970s."

Snow Fencing Details for Two and Four-rail Bridge Railing
NYSDOT Structures Design and Construction Division
http://dotweb1.dot.state.ny.us/caddinfo/structures/files/bdfd1.pdf

SNOW-ICE listserv
http://leadstates.tamu.edu/rwis/listserv/index.stm
You can search the listserv database for a complete archive of all messages sent to the SNOW-ICE listserv. To subscribe to the listserv, send e-mail to owner-snow-ice@list.uiowa.edu including a message asking to be subscribed to the SNOW-ICE listserv. To send a message to the list, use the e-mail address snow-ice@list.uiowa.edu

TRB Research in Progress
Conductive Concrete for Bridge Deicing and Anti-icing
http://rip.trb.org/browse/dproject.asp?n=5065
Contact: Nebraska Department of Roads at http://www.dor.state.ne.us/ or 402-471-4567
Project status: active
The ultimate goal of this research project is to implement a conductive concrete overlay on an existing highway bridge or an exit ramp designated by the department for deicing or anti-icing, using the mix developed at the University of Nebraska-Lincoln. UNL will design the electrode gridwork and determine the power consumption and operating costs for implementing this innovative deicing technology at full-scale. A control circuit will also be designed and implemented for deck heating operations. The potential pay-off of this project is tremendous. It would eliminate icy bridge roads for wintry travel safety and save lives.

TRB Completed Research
Evaluation of Different Winter Road Maintenance Treatments on the Laviolette Bridge
http://rip.trb.org/browse/dproject.asp?n=4072
Contact: Ministere des Tranports du Quebec at communications@mtq.gouv.qc.ca or 418-643-6864
Project status: completed 1993
The purpose of this project was to evaluate, in the field, various road treatments such as urea, abrasives, a mixture of abrasives and urea, as well as mechanical clearing (traditional shovel), and also to make appropriate recommendations based on the results obtained during the road tests. The effectiveness of different road treatments is assessed, at different intervals, by means of braking tests using a motor vehicle fitted with an electronic decelerometer. Each series of braking tests is accompanied by a qualitative evaluation (temperature, wind speed, quantity of precipitation, number of applications of the road treatment, road traffic density). The report suggests that, during a storm, the pavement should be cleared mechanically after every 0.8 to 1.2 inches (two or three centimeters) of precipitation. It serves no purpose to spread deicing chemical or abrasives before and during precipitation. Following a snowstorm and at a temperature above 17.6 degrees Fahrenheit (-8 degrees Celsius), mechanical pavement clearing, followed by an application of pure urea, is recommended. The road safety level is not increased at all by applying abrasives, even when spreading rates are as high as 0.25 ounces per square foot (78 grams per square meter).

HIGHWAY PLANNING

Design Guidelines for the Control of Blowing and Drifting Snow
SHRP-H-381, Ron Tabler
http://gulliver.trb.org/publications/shrp/SHRP-H-381.pdf
Click on bookmark for Section 7: Designing Drift-Free Roads.
This section provides guidelines for locating and designing roads to minimize blowing snow problems, derived from a combination of theoretical considerations, observation and a mathematical model for predicting snowdrift profiles. To the extent practicable, the guidelines proposed here are consistent with the recommendations in the Roadside Design Guide (AASHTO, 1989).

New York State DOT
CADD-based expert system for blowing snow control
Project manager: Joe Doherty, JDOHERTY@gw.dot.state.ny.us
The objective of this study is to develop an expert system to simplify the design of passive snow control measures, and facilitate application of a new technology to control blowing snow. Using climatologic and topographic data along with site-specific information provided by the user, the system will compute the directional distribution of snow transport and provide specific recommendations to avoid snowdrift encroachment and whiteouts. Partnering in the research and development are Brookhaven National Laboratory and the State University of New York-Buffalo, Joe says. The end product is a software program called SNOWMAN that will enable highway designers to model snow drifting scenarios for roadways under planning. Designers will input a road plan, and SNOWMAN will calculate a snowdrift scenario using data including wind speed and wind direction for the site. Designers can then adjust their plans in response. SNOWMAN will be able to work with variables including cross section, fills, cuts, uneven terrain, and snow fencing schemes. The initial research and development were expected to wrap up by early June 2003. The software was to be transferred to NYSDOT highway planners for operation on the NYSDOT design platform and further field-testing. It was expected that when SNOWMAN achieved optimum operation, it would be transferred to AASHTO for eventual distribution to interested states.

Wyoming DOT
Contact: Ken Shultz, State Maintenance Engineer
kshult@dot.state.wy.us
"WYDOT does indeed look at snow drift profiles when designing our roadways," Ken says. "We still don't have our routine into our GEOPAK software yet, but we used to have one that would plot the predicted drift profile on the old AASHTO Roadway Design System. (The GEOPAK product line is a comprehensive solution designed by civil engineers, structural engineers and professional surveyors used to tackle challenging civil engineering projects: http://www.bentley.com/industry_groups/default.cfm?objectid=37FBE1FB-4436-4EA2-AA0BE2DFF7B409AA&method=display) We're hoping that GEOPAK will get this for us in the not too distant future. As I understand it (I am not totally familiar with all the negotiations concerning this), it would be available as a part of the GEOPAK suite of products once it's done. Ron Tabler is the one who developed the logic behind this routine for us years ago. He has done some updating prior to our approaching GEOPAK.

"FYI, we have gotten pretty good at this, but we have forgotten some of our early lessons," Ken says. "Ron is teaching a course on this for 180 WYDOT people the end of (March 2003) as a reminder. The institutional knowledge that leaves with retirement and software changes can be a problem at times. Also, we have looked to using earthwork cross section modifications vs. snow fence, especially since there isn't much in the way of long-term maintenance cost for the dirt vs. the fence, but we lost the visibility improvements we received from the fence because of its ability to slow blowing snow. Some tough issues to prioritize at times."

North Dakota DOT
Contact: Ed Ryen, Assistant Maintenance Engineer
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"NDDOT does not build a lot of new roads as we, as well as a lot of states, are trying to maintain what we have. But, when we do, we take into consideration snow drifting and collection."

From: ***Technology News, September-November 2001***
Iowa State University Center for Transportation Research and Education
http://www.ctre.iastate.edu/pubs/Tech_News/2001/sepoct/managesnowdrift.pdf
Perhaps the best way to control drifting snow is to shape the roadside landscape appropriately. Ideally, this is accomplished when the roadway is designed, but sometimes the topography of existing roadways can be improved or reshaped in the following ways (implementing either technique likely requires a right of way agreement):

- Enhance ditches. Snow tends to accumulate in sheltered depressions rather than on the higher ground around the depressions. Widen and deepen ditches to increase their capacity to contain blowing snow and snow plowed off the roadway surface.
- Eliminate snow traps. Snow traps occur when roadsides are higher than the road's surface. Blowing snow collects and swirls in these depressions, creating hazardous road conditions. Eliminating snow traps involves removing embankments to flatten the adjacent roadside and constructing adequate ditches.

Snow Engineering: Recent Advances and Developments
This TRIS Online abstract is available at:
http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00802194&STARTROW=1&CFID=133674&CFTOKEN=21352106
Specialists in building and civil engineering, architecture, traffic and transport engineering, urban planning and regional development were brought together with snow scientists at the Fourth International Conference on Snow Engineering. The event belongs to a series of snow engineering conferences held every four years. The proceedings have been arranged in four thematic sections, including Transportation, which addresses road and railway engineering in snowy areas, friction on roads and airfields, and operation and maintenance of roads, railways and airfields. (Available from: Balkema (AA) Publishers, Old Post Road, Brookfield, VT 05036.)

Design Criteria for Roads in Snow-drifting Areas
This TRIS Online abstract is available at:
http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00925122&STARTROW=1&CFID=133674&CFTOKEN=21352106
This paper introduces some of the results for a research program including numerical experiments and field surveys. The research was done to enhance knowledge of drifting snow behavior on roads and also to develop design criteria for better road and highway construction in mountainous areas and other areas where frequent snowfall and strong winds occur. The research is based on Computational Fluid Dynamics (CFD) and field measurements. Simulations of wind flow are compared to snow cover surveys from roads in Ireland and Norway and the results have been used to develop recommendations for engineers. An important goal for this study has been to use CFD to develop geometric relationships that can be applied in road planning. The results presented in the paper include guidelines for evaluating the efficiency of natural snow deposition zones and their equilibrium snowdrift capacity. (Available from: World Road Association—PIARC, La Grande Arche, Paroi Nord, Niveau 8, F-92055 La Defense Cedex, France.)

Wind Effects on Snow Drifts Around Two-Dimensional Fence
This TRIS Online abstract is available at:
http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00803966&STARTROW=1&CFID=133674&CFTOKEN=21352106
This study clarified the relation between snow accumulation and wind flow by wind tunnel tests, snow wind tunnel tests and field measurements. The paper investigates snow accumulation and wind flow around a two-dimensional type fence with opening at the bottom. The snow accumulation around the fence was measured in a snow wind tunnel. Then, the wind flow around the models that simulated the snow accumulation around the fence was measured in detail by means of a triple-split probe anemometer in a boundary layer wind tunnel. The test results yielded the snow accumulation patterns around the fence with duration of snowfall and clarified the relationship between the snow accumulation patterns and vortices formed in front of and behind the fence. Results were verified by field measurements of the full-scale model. (The complete presentation is available from: Balkema (AA) Publishers, Old Post Road, Brookfield, VT 05036.)

An Approach to Cost Analysis and Prioritization of Snow Drift Treatments on Public Highways
This TRIS Online abstract is available at:
http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00751919&STARTROW=11&CFID=133674&CFTOKEN=21352106
Design treatments have been developed which can substantially mitigate snow drifting on highways but these have been applied to relatively few problem sites. The principle reasons for this are that costs and benefits are difficult to estimate, and highway designers often do not have the specialized expertise to design or select the optimum treatment for a particular site. An approach and toolkit have been developed to assist highway planners in estimating the costs of snowdrift treatments and in prioritizing expenditures at sites across a highway network. The toolkit includes a personal computer that estimates the severity of snow drifting, a life-cycle cost analysis of standard mitigative treatments, and a methodology for estimating direct and indirect benefits of the treatments. (The complete presentation is available from: Swedish National Road and Transport Research Institute, S581 95 Linkoping, Sweden.)

Snow Drifting Acoustic Detector
This TRIS Online abstract is available at:
http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00751926&STARTROW=11&CFID=133674&CFTOKEN=21352106
Blowing snow reduces visibility and creates snowdrift, posing economic and safety problems especially in regard to winter road maintenance. The Division Nivologie (Grenoble, France) designed a new gauge manufactured by Auteg to detect drifting snow. It has been tested in La Molina (eastern Spanish Pyrenees) during the winters of 1996 and 1997. Based on an acoustic principle, it consists of a miniature microphone located at the base of an aluminum pole of variable length. The pole is exposed to the snow particles flux, and while snowdrift occurs, part of the flux impacts the pole. The sound produced by these impacts is recorded as an electric signal. The lower frequencies due to the wind and the higher ones, out of audible range, are filtered. (The complete presentation is available from: Swedish National Road and Transport Research Institute, S581 95 Linkoping, Sweden.)

From: ***Road Management & Engineering Journal***
Winter Maintenance Technology and Practices—Learning from Abroad (March 1, 1997)
http://www.usroads.com/journals/rmj/9703/rm970302.htm
Scroll down to:
Winter Maintenance Management Systems
Highly effective snow fencing and other innovative winter highway maintenance technologies are possible partly because of Japan's Hokkaido Development Bureau Construction Machinery Engineering Center. At the center, a wind tunnel uses clay particles to simulate the effects of highway cuts, structures and facilities on blowing and drifting snow. The Hokkaido Office of the Japan Weather Association has also developed a computational simulation that presents in high-quality graphics information on decreased visibility, drift scour and snow accumulation.

IN EUROPE
Winter Maintenance in Europe—Practice and Research
http://www.dot.state.mn.us/maint/files/sirwec_cd/bald.pdf
The European Commission project entitled COST Action 344: "Improvements to snow and ice control on European roads and bridges" is an exchange platform between 19 European countries. The three-year project began in 1999 and is a part of COST-Transport "research for sustainable mobility." You can view the project Web page at http://www.cordis.lu/cost-transport/src/cost-344.htm.